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ABSTRACT

This report proposes a modification of Jean Piaget's concept of "creative abstraction," the mechanism of creative thought, which develops both intelligence and creative ideas. By reflecting on one's actions and the coordinations of actions, the individual constructs new relationships, links, rules, or correspondences between and among them. Reflective abstraction is important both in the growth and development of young children and in the creative work of adults. The report finds fault with Piaget's description of this mechanism in that it does not conceptualize the process sufficiently for either research or educational purposes. The paper also outlines the correspondences between models for creative problem-solving drawn from other research and reflective abstraction and amends Piaget's "dual process of reflecting and reflection" by hypothesizing that reflective abstraction is a six-step process. This model of the reflective process is presented from the beginning, when an individual becomes aware of a problem, through the final resolution of the problem. Finally, the report illustrates the workings of reflective abstraction with reference to the creative work of scientists and artists. (RH)

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REFLECTIONS ON REFLECTIVE ABSTRACTIONS IN CREATIVE THINKING

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REFLECTIONS ON REFLECTIVE ABSTRACTIONS IN CREATIVE THINKING

At the Eisenhower Symposium at Johns Hopkins in 1972, Piaget said that "All actions, all acts of intellectual creativity are processes of reflective abstraction," (Piaget in Gallagher, 1981, p. 225) as novelty is created through reflections on one's actions. Through this statement, he implied that reflective abstraction is the mechanism for the development of both intelligence and creative ideas or products, the same mechanism operating in the child as in the eminent creator.

Yet, despite Piaget's direct linking of creativity and reflective abstraction, few researchers have pursued this connection with some notable exceptions, particularly the works of Gallagher and colleagues, and D'Onofrio (see Gallagher, 1978; Courturier, Mansfield and Gallagher, 1975; Gallagher and Mansfield, 1980; Gallagher and Wright, 1977; Noppe & Gallagher, 1976; D'Onofrio, 1982, and D'Onofrio, Gallagher & Wright, 1981).

This lack of research may be due to difficulties in Piaget's description of the mechanism. This paper proposes a revised conception of the process, particularly for Type II and Type III equilibrations.

We shall first consider what is meant by reflective abstraction; look at Piaget's description of how the mechanism functions, see its role in the three types of equilibrations, and examine possible inadequacies in the original conception of the mechanism. We shall then look at two models of creative problem solving, and propose a revised conception of reflective abstraction tied to the creative problem solving notions, with focus on sites of difficulty in creating. We shall look at reflective abstraction as a deliberate process in the creator and conclude with some thoughts on the relevance of all this to the distinguishing features of the thought of gifted and creative thinkers.

The Meaning of Reflective Abstraction

According to Piaget (1977), when a new problem is confronted, the individual can go beyond the observables and put them into relationship, resulting in logico-mathematical knowing or endogenous knowledge. By reflecting on one's actions and the coordinations of actions, the individual constructs something new....the relationships, links, rules or correspondences between and among them. This reflective abstraction activity begins in earliest infancy (according to Gallagher and Reid, 1981).

Reflective abstraction is the linking mechanism in equilibration that moves the individual from one level to the next. It is the mechanism that constructs novelty.

Piaget (1981/1972) characterized reflective abstraction as being composed of two inseparable aspects. The first is a physical sense of reflecting or projecting (like a mirror) to a higher level what is known on a lower level. From toddling, for example, to thinking about toddling is a transposition to a higher level of construction, providing a wider, greater view of one's actions. The second aspect, reflection, is a reorganization or reconstruction (more a conscious aspect) at that higher level of what has been projected, enriched with new elements. The toddling baby has enriched his action of walking to representing to himself the room in which he toddles and where he is at each point in the room. He has a representation of the whole which gives the possibility of reversibility, whereas before, the baby could only use the indicators of the present moment to find himself in space. Through reflective abstraction, his actions are both transposed and enlarged.

Three Types of Equilibration

Reflective abstraction is the mechanism for development in the three types of equilibration: simple equilibration of objects to schemes, recip-

rocal equilibration, and hierarchical equilibration of totalities (Piaget, 1977). To help conceptualize these, it might be useful to use a metaphor, one of sturdy and highly stretchable rubber bands!

Type I - Simple Equilibration

Schemes could be thought of as simple rubber bands, floppy in the infant with much stretchability, and with elements easily slid in and out. A simple equilibration is an extension of the rubber band to accommodate new elements from the outside. The baby finally manages to catch hold of a tantalizing, eye-level cat's tail and bites down hard on it with her four teeth. She is constructing her scheme of eating. The resulting ball of spitting, scratching fury and a mouthful of fur besides rather quickly allow her to construct a negation--long, plumy things attached to four legs are not edible! She has projected form the plane of action (biting the tail) to a plane of thought (the image of herself testing cat tails) and has reconstructed at that higher level the notion that some things are tasty, others definitely not! Her scheme of edibility is both enlarged and enriched. The rubber band has been stretched. We can hypothesize that in gifted and creative individuals, these rubber bands have great extension capacities.

Type II - Reciprocal Equilibration

In reciprocal equilibration resulting from interactions between subsystems, two rubber bands, each containing a scheme or subsystem are snipped through the action of the subject, (reflective abstraction) and the ends joined to form a larger structure. Elements inside must be enriched and reorganized to fit together in this new, larger rubber band.

Since Piaget noted that reflective abstraction is the mechanism of creative thinking in both child and adult, let us look at an example in an older thinker. In the adult, we have active concept schemes or subsystems

which Gruber (1981a) calls enterprises. These are areas of great assimilatory activity and can therefore be likened to action schemes. For example, we may have an active Piagetian scheme and an active scheme of Erikson's ego development. Through reflective abstraction, we may construct the notion that the problem for the age in the psychosocial realm relates to the areas of cognitive development Piaget described. By constructing the idea of the universal cognitive problem of the age through bringing together Erikson and Piaget, we reciprocally equilibrate.

Type III - Hierarchical Equilibration of Totalities

In equilibration of totalities, through reflective abstraction (or abstractions) about thought, there is both the snipping and joining of rubber bands to make a huge structure, and the separating and recombining of elements within smaller rubber bands in that large one as subsets, a process of hierarchical integration and differentiation of parts to whole.

The Problem With Reflective Abstraction

The problem with Piaget's two part description of reflective abstraction is that it may not capture the process sufficiently to be useful for either research or educational purposes. The putting into relationship is not the same as constructing the relationship. If strategies for creative problem solving from the worlds of industry and education can be brought to bear on this mechanism, a clearer, more useful construct may emerge.

Creative Problem Solving

The models selected below are representative of several similar models that suggest steps or stages in creative solution. In 1926, Wallas introduced the following steps in creative production:

1. preparation (information gathering)
2. incubation (unconscious work going on)
3. illumination (inspired solution emerges)
4. verification (solutions are tested and elaborated).

Vargiu (1977) added a step between preparation and incubation: That of perturbation.

Keeping this latter model in mind, let us look at the five Creative Problem Solving (C.P.S.) stages of Osborn (1963) and Parnes (1967):

1. fact finding
2. problem finding
3. idea finding
4. solution finding
5. acceptance finding.

We can think of equilibration as a kind of creative problem solving. One attempts to assimilate an element (or coordinate substructures) and finds that one's present structures cannot deal with it (them). A conflict, gap, contradiction or perturbation (in short, a problem) is experienced, causing a state of disequilibrium. One must deal with the inconsistency and solve the problem in order to accommodate the discordant element and return to a state of enriched equilibrium.

If we can compare the strategies for how a problem is solved from beginning to end with reflective abstraction, we may have a more useful notion for both teaching and research.

Reflective Abstraction -- An Hypothesized Six-Step Process

Piaget (1977) had stated that reflective abstraction is a dual process of reflecting and reflection. It appears to be more a six-step process, particularly in creativity, as thinking about or reflecting on one's actions begins at an earlier point in the process, especially in Type II, reciprocal equilibrations, and Type III, hierarchical equilibrations of totalities.

It starts as a hunch, a sensing or feeling of something not quite right with one's present way of thinking.

1. Encoding

Sternberg (1985) defined encoding in analogical solution as a process of identifying each element and retrieving from long term memory attributes relevant to solution. He found that attention to this step is the hallmark of the good problem solver. Encoding here means an attempt to assimilate the observables or thoughts to a wide variety of schemes, or extension of a scheme thorugh generalized assimilation. In short, it is a tying-in to everything one knows, a period of emersion in the material. This can be seen as a building up of a content base, an openness to ideas in breadth, depth or both. It is similar to the C.P.S. fact finding stage and to Wallas' preparation stage.

2. Conflict or Contradiction

As the individual builds a base of information, some elements are found that cannot be assimilated to an existing structure, as they do not fit. A perturbation, gap, or other type of contradiction (Piaget, 1980), is experienced. There is a willingness, perhaps even enjoyment to endure this disequilibrium in the creative thinker. This step is similar to the notion of perturbation that Vargiu added to the Wallas model and also to the C.P.S. "mess" phase of the stage of problem finding.

3. Coordination

The individual attempts to coordinate or bring together any elements from diverse schemes or structures that can bear on the problem, and tries to construct relationships between and among them. This can be seen as "wide-active inference," a term Heller (1979) applied to the unconscious assimilation of a given stimuli to a wide variety of schemes which may lead to reciprocal equilibration. The individual may use metaphors or images here

in an attempt to move to resolution. This would be more like the C.P.S. notion of idea finding than Wallas' notion of incubation, which was seen largely as an unconscious process. The techniques for idea finding proposed by Parnes might be particularly helpful in leading to successful coordinations.

4. Destructuring

In order for the individual to put the new constructions into the system, the individual has to "destructure" h/sr systems back to a decision-making node (a term used by Gruber, 1981a). The neurological metaphor is the "pruning" aspect of brain development in which unneeded connections are eliminated (Epstein, 1982). Kuhn (1979) noted that the most difficult obstacle in development is "not the mastery of new strategies, but the ability to give up less adequate ones" (p. 356). It may be that this destructuring aspect in the adult is the construction of the negation Piaget (1977) described, denying in one's thinking one's former beliefs and understandings.

It must be noted that the entire system is not in chaos. Instead, one has to "unzip" the structure to the node where construction began on that particular problem and start rebuilding from that point. Neither Wallas nor Parnes-Osborne focus on this aspect.

5 & 6. Dual Process of Reflecting and Reflection

Reflection to a higher level can occur and the structure can be reorganized integrating old and new. The fourth stage of C.P.S., solution finding, where criteria is set for resolution, fits more here, as does the illumination phase suggested by Wallas. However, the sudden eureka experience or flash of insight expressed as illumination is not necessarily the way one develops solution.

The major difference between reflective abstraction and problem solving is that in this revised notion of reflective abstraction, a stage of

destructuring is explicit, while in both C.P.S. and the Wallas paradigm, acceptance finding or verification are considered.

What we have in this six-step process is a view of the reflective process from the beginning when one begins to think about the felt, but still hazy problem to the final placement of the solution into the system.

(TABLE 1 ABOUT HERE)

The Site of Difficulty in the Creative Process

Gruber (1981) found that although Darwin had essentially constructed his theory of evolution during 1837 and 1838, it took over twenty years for him to integrate it fully into his systems and to write the Origin of Species. Furth (1981) noted that although the seeds of equilibration theory had been in Piaget's work for over fifty years, it took that long for him to bring it all together and reconstruct it at a higher level in his 1975 book, The Development of Thought. Although putting it into the system really refers to tying it into the total structure and reorganizing that structure at a higher level (a Type III equilibration), this process msut occur thorugh the mechanism of reflective abstraction. Certainly hundreds if not thousands of reflective abstractions occurred along the way, in the case of either Piaget or Darwin, but the major reflective abstractions that relate to Type III equilibrations which had to occur, can be thought of as having the difficulty of a shift from step three to steps four, five and six. Although elements may be coordinated and constructions made, perhaps as insights, perhaps as a result of more even and steady functioning, this process can be very rapid as compared to the slow process of putting it into the total structure by destructuring and then reorganizing that structure to accommodate the new

TABLE 1

Steps in Creative Solution and Revised Reflective Abstraction

Wallas (1926) & Vargiu (1977) Creative Production	Osborn (1963) & Parnes (1967) Creative Problem Solving	Revised Six-Step Reflective Abstraction
Preparation	Fact Finding	Encoding (attempted Assimilation)
Perturbation (Vargiu)	Problem Finding	Conflict or gap
Incubation	Idea Finding	Coordination
Illumination	Solution Finding	Destructuring {Reflecting {Reflection
Verification	Acceptance Finding	

elements. In other words, the hard part is giving up the old and the reorganization of systems.

Gruber (1981a) found that effective thinking requires a balanced relation between these two aspects: The generation of isolated ideas of considerable originality are rapidly emitted; then the reconstruction of these ideas into a coherent system, which is a much slower process.

This dialectical process is also the process described by other creators. For example, Romare Beardon (Burch, 1972), an artist of the Black ghetto stated, "That the artist has to be something like a whale that swims with his mouth open, and absorbs everything until he has what he really needs. When he finds that, he can start to make limitations. Then he really begins to grow."

Landscape architect, Roberto Burle Marx (Cohen, Two Brothers in progress) stated that creativity is an alternating process of "restraining and giving wings" (restrenando e dando asas). For both of these creators there is the wide open aspect which can be seen in steps one through three, (openness to ideas, willingness to disequilibrate, making coordinations to find any aspects that might bear on solution) and the restricting or limiting aspect (selection for Gruber, 1982; or evaluation for Neimark, 1980) that results in the destructuring and the original notion of reflective abstraction, steps four, and simultaneous five and six.

Deliberate Process in the Creator

In the adult, reflective abstraction may be quite consciously or deliberately used. In an attempt to reach a higher level, the creator may deliberately use: 1) a different mode of thought (symbolic, figural, behavioral, or semantic, 2) playful assimilation without accommodation, or 3) an "image of

wide scope." They occur in the proposed third step, coordination.

1. A Different Mode of Thought

An image, metaphor, pattern of actions, or symbols may be developed that allows the grasping of relationships. For example, Darwin constructed the image of the irregularly branching tree of nature to help him construct the genealogical relationships among species, both living and extinct (Gruber, 1981a).

2. Playful Assimilation Without Accommodation

Although Piaget did not pay attention to the role of this type of figurative thought (imaging, etc.) at higher levels of development, (he did recognize a gap in this area - Piaget, 1963), one aspect of his repeated acknowledgement that childhood is the most creative period might be interpreted as being based on symbolic play or imagining--assimilation without accommodation, the chance to "try out the world" before integrating it. It may be that in the creative adult there is more assimilation without accommodation. In the free imagining or use of imaging via analogy or metaphor, the creator may attempt to explore the possibilities before committing himself or herself to construction of a structure. For example, in order to grasp the relationships of Piaget's concepts of structure, equilibration and reflective abstraction, one might play with several images - the construction of a building or the making of a painting, for example, paralleling each notion to an aspect in the construction of the building or painting. It is also a reflective process of putting into abeyance a scheme of possibilities that may help in the move to a higher level of understanding.

3. Images of Wide Scope

This kind of reflective symbolic play may sometimes result in what Gruber

calls "an image of wide scope" (1981b), a construction that gives a wholeness to very complex interrelationships in a metaphorical or shorthand form, a creative borrowing from other disciplines (Gruber, 1982). The irregularly branching tree of nature mentioned earlier became such an image of wide scope for Darwin. However, in the case of images of wide scope, the sought for relationships are constructed, the existing structure "unzipped" and the dual process Piaget described for reflective abstraction, leading to deep levels of equilibration occurs.

Gifted and Creative Thinkers

A major difference between gifted and creative individuals and less able peers is reflective abstraction. Although all individuals construct their logical structures using these mechanisms, the difference seems to be that average individuals are characterized more by thought about the concrete, the empirical, the observables, while gifted and creative persons tend to put things into relationships as much as possible. They reflect on the world around them and on their thoughts. While the average individual is content to describe the plays of a football game or the saga of a soap opera on television (empirical events), the gifted/creative individual might look at the same soap opera and relate it to historical antecedents such as the fall of Rome, or to the peculiarities of American culture, or to h/sr own attraction to the characters and how the soap opera fulfills certain psychological wishes--in short, the relationships behind the content. This is not to say that a gifted individual couldn't look at a football game or soap opera on purely the empirical level, but that there is a possibility of going beyond, an openness to questions or disturbances that arise from the content.

The gifted individual may be more likely to use reflective abstraction based on externals - either the material itself sets up disturbances which

s/he reflects upon, or there is an externally set task, expectation, or goal which s/he wishes to achieve. The creative thinker is likely to be more stimulated by internal needs, such as disequilibration between subsystems, a vision of a vision of possibilities in a domain, or the system of purposes, that Gruber (1981a) described as directing creative development. In the self-direction toward higher states of equilibrium, through thought about thought the creator senses or feels contradictions to the knowing structures. An active searching for elements that can help fill the gaps or resolve the conflicts or perturbations occurs, both internally and externally. Wrestling with both thought and novel elements from the outside, the creator encodes or attempts to assimilate, finds the contradiction, and attempts to make coordinations. Finally, with time and much effort the creator "unzips" the structures to a point where the new construction can fit, projecting what is known to a higher level and reorganizing it along with the novelty at that higher level. Only these last two steps are reflective abstraction, according to Piaget. However, the six-step mechanism proposed in this paper begins at the beginning, with the first reflection on or thinking about the sensed problem. Reflective abstraction is now tied into the total equilibration process, especially for the Types II and III equilibrations evident in creative thinking. Perhaps a more useful notion for education and research is offered, as each step in the process can be considered....And keep your rubber bands s-t-r-e-t-c-h-ing!

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